

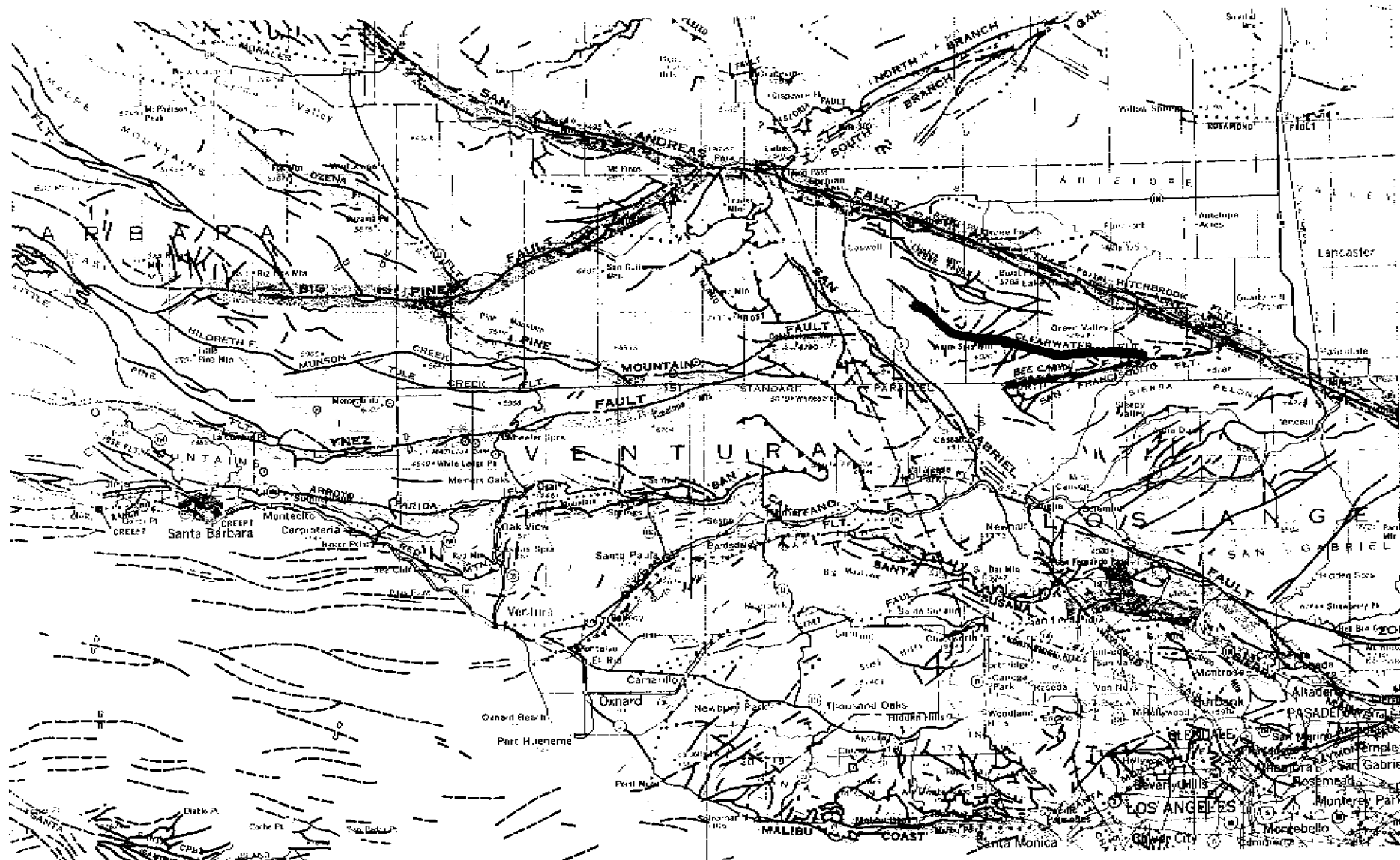
CALIFORNIA DIVISION OF MINES AND GEOLOGY

Fault Evaluation Report FER-60

September 29, 1977

1. Name of fault: Clearwater fault.
2. Location of fault: Liebre Mountain, Whitaker Peak, Warm Springs Mountain, Green Valley, and Sleepy Valley 7.5 minutes quadrangles, and perhaps the Ritter Ridge 7.5 minute quadrangle, Los Angeles County (see figure 1).
3. Reason for evaluation: Part of a 10-year program.
4. List of references:
  - a) Bettinger, Charles E., 1948, The geology of portions of Beartrap Canyon and Quail quadrangles, California: Unpublished M.S. thesis, University of Southern California, 48 p., map scale 1:24,000.
  - b) Crowell, J.C., 1968, Movement histories of faults in the Transverse Ranges and speculations on the tectonic history of California In Proceedings of conference on geologic problems of San Andreas Fault System, Dickinson, W.R., and Grantz, A., eds.: Stanford University Publications, Geological Sciences, v. XI, p. 323-341.
  - c) Dibblee, T.W., Jr., 1961, Geologic map of the Bouquet Reservoir quadrangle, Los Angeles County, California: U.S. Geological Survey, Mineral Investigations Field Studies Map MF-79, scale 1:62,500.

FIGURE 2. General location of the Clearwater fault (Jennings, 1975, scale 1:750,000), also showing the Bee Canyon fault of Simpson (1932).



- d) Jennings, C.W., 1975, Fault map of California with locations of volcanoes, thermal springs and thermal wells: California Division of Mines and Geology, Geologic Data Map Series, Map no. 1, scale 1:750,000.
- e) Konigsberg, Richard, L., 1967, Geology along the San Francisquito fault, northwest Los Angeles County, California: Unpublished M.S. thesis, University of California, Los Angeles, 84 p., map scale 1:12,000.
- f) Los Angeles County, Department of County Engineer, Engineering Geology Section, June 1965, Engineering geologic and foundation investigation proposed bridge site San Francisquito Canyon Road over Los Angeles City Department of Water and Power aqueduct: Unpublished report, Department of County Engineer, Los Angeles, California, 7 p., geologic map scale 1:6000.
- g) Nickell, F.A., 1928, The geology of the southwest part of the Elizabeth Lake quadrangle between San Francisquito and Bouquet Canyons: Unpublished M.S. thesis, California Institute of Technology, 24 p., map scale 1:31,250.
- h) Simpson, Edward C., 1932, Geology of the Elizabeth Lake quadrangle, California: Unpublished Ph.D. thesis, University of California, 167 p., map scale 1:62,500.
- i) Stanley, K.O., 1966, The structural history of the Clearwater fault, northwest Los Angeles County, California: Unpublished M.A. thesis, University of California, Los Angeles.  
Note: Not readily available, but cited by Crowell (1968).

- j) Szatai, John E., 1961, The geology of parts of the Redrock Mountain, Warm Spring, Violin Canyon, and Red Mountain quadrangles, Los Angeles County, California: Unpublished Ph.D. thesis, University of Southern California, 164 p., map scale 1:24,000.

5. Summary of available data:

The literature presents a confusing picture of the nature and linear extent of the Clearwater fault (plates 1A, 1B, 1C, and 1D). For the purposes of this FER, the discussion will be limited to the Clearwater fault as described by the various authors. Most authors agree that the fault highlighted in red in figure 1 is the Clearwater fault; some authors believe the red queried trace is also part of the Clearwater, some believe it is the San Francisquito, and some believe that the two merge. Whatever the case, the discussion is limited primarily to the red highlighted trace.

Additional traces or segments are discussed primarily so that any one author's data, <sup>relating to what he believes <sup>to be</sup> the history of the fault</sup> can be totally considered.

Nickell (1928, p. 20) first described the Clearwater fault as a south-dipping (66°) thrust along which 2100 feet of displacement had occurred since Eocene time.

Simpson (1932), who remapped the same area, described the Clearwater (he called it the Bouquet Canyon fault) as a vertical fault. Simpson felt that the Clearwater extended eastward to the San Andreas fault (the queried, red highlighted trace in figure 1). He noted (p. 114) that one secondary fault, located north of the main trace (Simpson does not give any more information as to the location), "... is visible for several hundred feet marked by a six-foot high scarp so new that vertical striae on its slickensided surface are still plainly visible." While the scarp is probably present (see items 6 and 7), slickensides can be preserved for a very long time (millions of years) if they are not exposed to the

atmosphere; thus, this explanation does not in itself prove the fault recently active, but only recently exposed. It also demonstrates that dip-slip movement has occurred. Simpson (p. 120-121) attempted to classify the faults within his field area according to age of most recent movements. He divided his "live" faults ("those judged to be still active, along which displacements may be expected to occur in the future") into two sub-classes: those that "show evidence of recent movements" (San Andreas, Garlock, Oak Creek Canyon, and Rosamond faults); and, those that show evidence of activity during the Quaternary, but not "recent" (Clearwater, Pelona, and Bee Canyon -- the latter is shown in blue in figure 1). He noted some "dead" faults were present as well.

Dibblee (1961) shows the Clearwater fault as buried under Quaternary terrace deposits <sup>east</sup>~~west~~ of San Francisco Powerhouse no. 1 (plate 1C).

Bettinger (1948, p. 40) noted a general alignment of canyons along the Clearwater fault; however, such features could be due to differential erosion.

Szatai (1961, p. 132-133) mapped an area immediately west of Simpson's. He noted that the Clearwater fault is well-exposed in several localities, and generally dips northeast 75°-80°, and locally 50°. Szatai stated that the Clearwater was a right-lateral fault, along which two miles of displacement had occurred, based on the apparent right-lateral displacement of the base of the Modelo Formation. Because the fault "dies out" before reaching the Peace Valley Formation to the west, he concluded that the fault was pre-Peace Valley (late Pliocene) in age, but post-Ridge Route Formation (early Pliocene) since it cuts the latter.

Konigsberg (1967, p. 53-54) felt that the Clearwater and San Francisquito faults join under Bouquet Reservoir. He noted that the Clearwater fault dips  $80^{\circ}$  to the north, and (citing Stanley, 1966) that the fault does not cut the Ridge Route Formation west of his (Konigsberg's) field area. Note also (plate 1D) that Konigsberg depicts the Clearwater-San Francisquito fault as buried under terrace deposits (late Quaternary) near the eastern margin of the Sleepy Valley quadrangle.

Crowell (1968, p. 324), citing Stanley (1966), concluded that the Clearwater fault has not been active during the Pleistocene because a Plio-Pleistocene unconformity is not offset. However, Crowell (p. 327, figure 3) graphically depicts the Clearwater fault as having been active during the late Pleistocene.

Finally, Los Angeles County (1965) conducted an investigation in which they concluded that the Clearwater fault was primarily a dip-slip fault, with little evidence of strike-slip movement. The fault is described as a north-dipping, high-angle, reverse fault with some thrust components. The report concludes that the thrusting is more recent than the reverse faulting, because the thrust fault has clearly displaced Pleistocene terrace deposits while the reverse faults have apparently not. This movement has taken place within the last 400,000 to 500,000 years (their dates). The steeper reverse faults show no evidence of Pleistocene activity.

The high-angle, reverse fault traces mapped by Los Angeles County are described as being fairly narrow, but they note that geomorphic expression suggests the zone is about 1500 feet wide. The reverse fault was well-exposed in a road cut, where gneissic rocks were clearly thrust over non-marine terrace deposits.

## 6. Interpretation of air photos:

Fairchild air photos, flight C-17727 (1952, 1:1000 scale), numbers 8-20 to 8-35 were viewed stereoscopically. Scarps and uplifted drainages were noted along a rather sinuous trace, suggestive of a thrust fault, for several miles (see plate 2). Lineations (tonal, vegetation, etc.) were also noted along the same trend. Similar, but less continuous features were noted within the northern block as well. The pattern of all of these features suggests relatively recent movement along a north-dipping thrust fault, at least in and near the Green Valley quadrangle. Similar features do not appear to exist, or are not as well-defined, within that segment of the fault which is <sup>within the</sup> zone <sup>most of</sup> in the Sleepy

Valley quad; however, stereo coverage of most of this area was not readily available at this early stage, and thus more well-defined features may, in fact, exist within or near the zone.

## 7. Field observations:

On August 6, 1977, I examined the Clearwater fault from Bouquet Reservoir to Ruby Canyon. Where Spunky Canyon Road crosses the fault (north of Bouquet Reservoir), a shear zone at least 100 feet thick is visible in the road cuts (figure 2). At least two major faults could be distinguished within the shear zone, dipping about 37° northward. These faults were observable in the road cuts at all three places where the road crosses the fault. Unfortunately, the Cherry Canyon area to the west was closed to entry due to extreme fire danger.

North of San Francisquito Power House no. 1, the Clearwater fault crosses a road now being realigned. While the road cut referred to by Los Angeles County (1965) (see item 5) is no longer present, there are some new, extensive road cuts in which the fault is well-exposed (see figures 5 through 8). I examined the "terrace deposits" referred

Note: Color prints in pocket.

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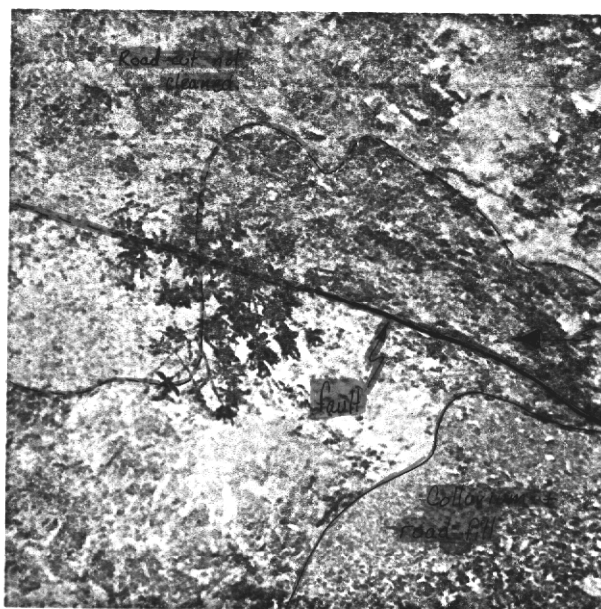


Figure 2. View of fault in road cut at Spunky Canyon Road.

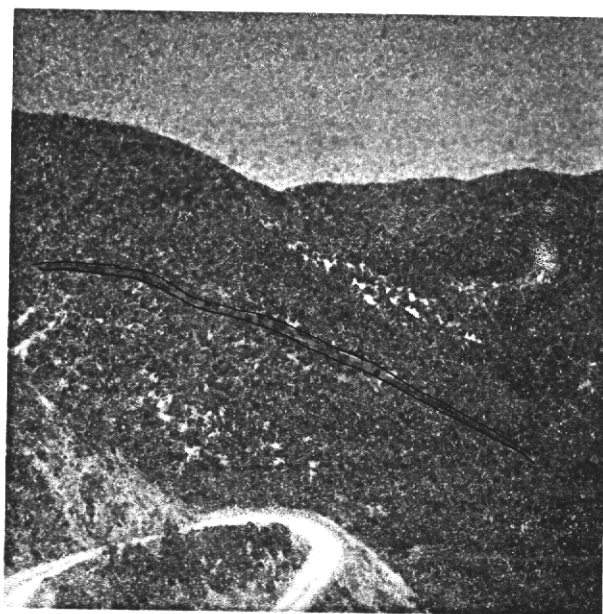


Figure 3. Escarpment, probably a fault scarp, trending east-west, about 10 feet high; north of Clearwater Canyon.



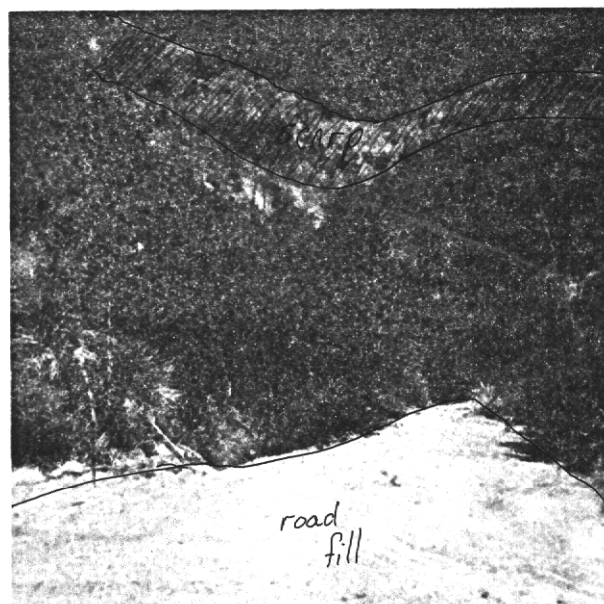


Figure 4. Typical nick point in stream profile. Gray material is mostly fault gouge and breccia.

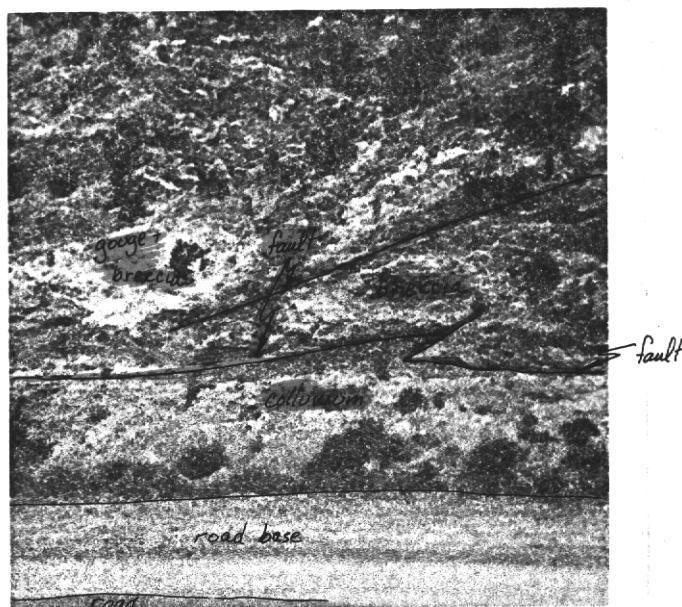


Figure 5. New road cut north of Power House No. 1. View looking north. Road cut approximately parallels strike of fault. Below fault plane is colluvial material. Estimated dip-slip displacement is several tens of feet.

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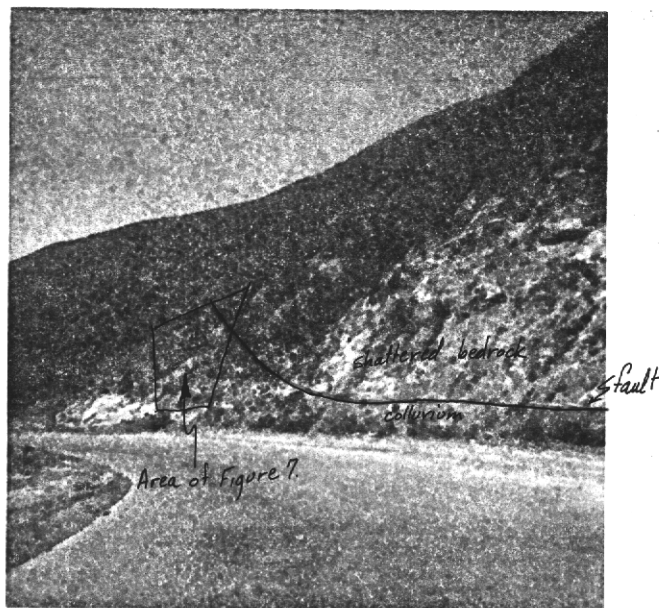


Figure 6. Looking west, just west of figure 5.

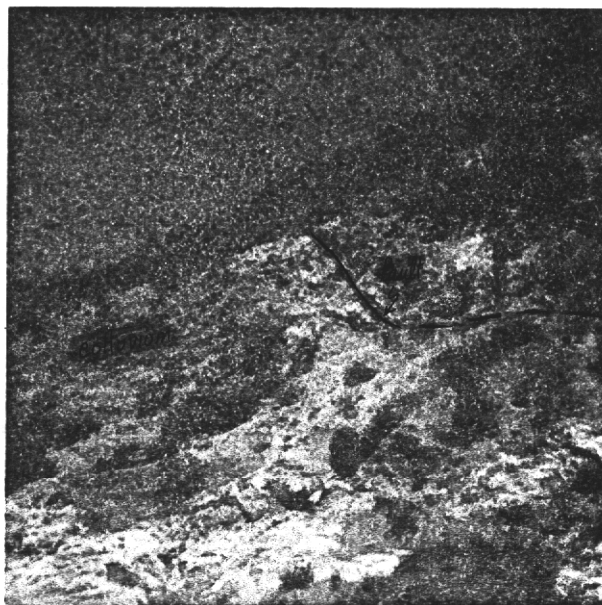


Figure 7. Close-up of part of Figure 6, looking uphill and NW.

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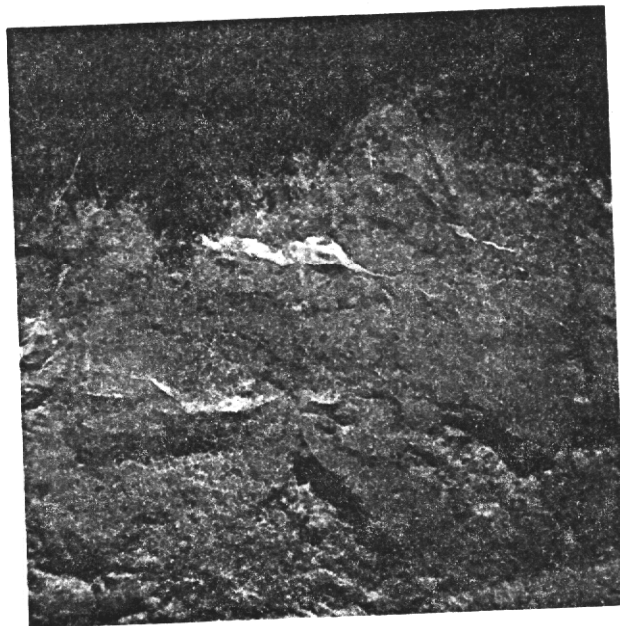


Figure B. Colluvial material which is part of the deposit overridden by the Clearwater fault.

to by Los Angeles County and concluded that these were probably colluvial deposits. These deposits have apparently been overridden a few tens of feet, based on the amount of material estimated to have been removed for the road cuts noted above, by sheared gneissic material. Modern soil horizons apparently have not developed, and thus, are not available for examination.

Other diagnostic fault features were not noted in Clearwater and Ruby Canyons during this limited reconnaissance. Ruby Spring seemed to be the only site <sup>west of the powerhouse</sup> where there might possibly be young soil <sup>or alluvial</sup> material, which may be datable and which has or has not been overridden by the fault.

#### 8. Conclusions:

The Clearwater fault has probably been active during the late Pleistocene (Los Angeles County, 1965; Item 6), and perhaps even during the Holocene (Item 6) within the area where the fault is reasonably well-defined (from Two Shay Ranch (Sleepy Valley quadrangle)) to Ruby Spring (Warm Springs Mountain quadrangle) by geomorphic features. However, a rather wide crushed zone is present. Since young deposits are often absent along the trace it is necessary to rely on geomorphic evidence in order to determine which fault trace was most recently active. However, the <sup>evidence</sup> geomorphic only suggests recent activity; Holocene activity has not been proven. Some questions still exist regarding the age of the geomorphic features present in old, weather-resistant bedrock. West of Ruby Spring, the topographic features are distributed over a wider area, are less impressive, and, therefore, do not point to a single trace. I have found no data, other than from air photos -- and the western end of the fault was not examined in detail on air photos -- that would indicate that the

western end of the fault is Holocene, or even late Quaternary. There is conflicting data regarding the eastern segment (east of Bouquet Reservoir), especially if one were to consider any of the data available on the San Francisquito fault, most of which has not been discussed in this FER.

9. Recommendations:

More work is necessary to determine whether or not the fault is active. There is not yet enough information available for zoning to be recommended. This work should consist primarily of further air photo interpretation, and field examination of those geomorphic features which could be fault produced.

What has been called the San Francisquito fault, is already zoned (under the A-P Special Studies Zones Act) within the Sleepy Valley quadrangle. It is quite possible that this is an eastern extension of the Clearwater fault. Thus, any further investigation of the Clearwater fault should also be directed at that part of the "San Francisquito" already zoned. It is desirable that a separate FER be completed summarizing the data available on the San Francisquito. It is conceivable that most or all of the SSZ, within the Sleepy Valley quad and not related to the San Andreas fault, could be deleted. Indeed, since Konigsberg (1967) shows this segment of the fault as buried under Quaternary terrace deposits, it is questionable whether the fault should have been zoned in 1974, even given the different set of guidelines which were then used. (See also the recommendations contained in FER-5.)

Based on the information summarized in this report, and the present project guidelines, zoning of the Clearwater fault cannot be recommended at this time. More work is needed to answer the critical question regarding recency of movement. The recent geomorphic features present within the Green Valley and parts of the Warm Springs Mountain and Sleepy Valley quadrangles would argue for assigning the fault a relatively high priority for further investigation; however, the area is sparsely populated with only two small communities located near the fault, in an area that is mostly owned by the U.S. Government. Thus, the low probability of future, major development near the fault would lower the priority for additional work *as part of this project.*

10. Investigating geologist's name; date:

*Theodore C. Smith*

THEODORE C. SMITH  
Assistant Geologist  
September 29, 1977

*I recommend against going  
unless further work indicates  
that the well-defined fault segments  
have sufficient evidence of Holocene  
activity. A moderate priority for  
further field work (check late Quat.  
deposits for fault features) is indicated.  
Such work should include the San Francisco  
segment (abruptly zoned) to the East (see FER-5  
and work of Kahle, et al).  
ECS  
10/25/77*